

*Application for*  
**UNITED STATES LETTERS PATENT**

*of*

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*for*

**IMPROVEMENTS IN A PROCESS FOR OBTAINING HYDROGEN**

## IMPROVEMENTS IN A PROCESS FOR OBTAINING HYDROGEN

*[[Translator's Note: Further to the above recited legend at the reverse of each and every sheet of this document, all the following sheets also have a legend reading: Blank Page ]]*

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### TECHNICAL FIELD OF THE INVENTION

This invention relates in general to industrial processes for obtaining gases and, more particularly, to processes for obtaining hydrogen gas by electrolytic means.

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### BACKGROUND OF THE INVENTION

One of the processes in the present days for obtaining hydrogen by electrolysis consists in the decomposition of water in the interior of a container, by passing a unidirectional electric current (direct current, DC), through the use of a pair of electrodes and, in some cases, through the use of a membrane between said electrodes in order to avoid the admixing of the gases obtained.

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This process is broadly known and the main disadvantage thereof is the high cost of the process, due to the high cost of electricity, further to the polarization phenomenon related to a high degree of purity.

Taking into account the prior art disadvantages, the inventor carried out a number of studies, tests and experiments, which resulted in a novel improvement to the process for obtaining gases by electrolytic means, which is no doubt of highest

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importance for the portion of the technique to which this invention belongs.

For all the above, the inventor searched various alternatives, one of which was considered as the most attractive from the technical and economical points of view, consisting in an improvement to the system for obtaining gases by electrolytic methods, comprising the application of the same electrolysis phenomenon, i. e., the passing of a CD electrical current through electrodes submerged in the sea, to a great depth, that is, in a sodium chloride solution, under a great pressure. When the sea water is decomposed by the passing of the electrical current, hydrogen gas is formed as small bubbles. These bubbles, due to the so-called Archimedes Principle, exert an upward thrust, proportional to the dislodged water volume; with said bubbles being received in a tube which can be totally or partially opened at the bottom and extending from the electrode site upwards into the sea surface. Said tubes serve as a duct for the bubbles up to the surface; and as the thus obtained gas travels up the tubes, with said tube being closed at the top, a gas pressure is growing up due to which some sea water is displaced by said gas; and as more hydrogen gas is accumulated, a greater sea water volume is displaced downwardly, thus increasing the tubes pressure. Said pressure is employed to generate a motion, either in a turbine or any other known machine, mechanically coupled to a power generator; so that power is generated to feed the electrodes, which

will continue to decompose by electrolysis said sea water. This power generator can be of DC, that can be applied directly to the electrodes, or else can be of alternating current (AC) that is then rectified prior to the feeding thereof to said electrodes.

5           A benefit of this system is that no polarization phenomenon is present between the electrodes, that could reduce the hydrogen production, since said electrodes are free within an open means, where there are water currents continuously changing the water being subject to electrolysis.

10           The principle on which the improvement is based is that the amount of the element obtained by electrolysis (in this instance hydrogen) depends on the molar mass of the element and the amount of electricity (ampere-hour) circulating through the compound (in this instance sea water) and is independent from the  
15           pressure to which the material to be decomposed is subject; in such a manner that, said small bubbles have a chance to carry out a work due to the thrust of the water during their traveling up to the surface; and the deeper the electrodes are located, the greater the amount of work said bubbles are capable of carry out.

20           An advantage of this process is that the bulk cost of obtaining hydrogen by means of electrolysis can be reduced due to the taking advantage of the energy produced when the gas travels up to the sea surface.

The main object of the present invention is to provide an improved system for obtaining gases by means of electrolysis, in such a manner that the thus obtained gas is able to carry out a mechanical work, which can be transformed into electric power to be feedback to the electrolytic device, thus increasing the efficiency of the system and producing a save in the process operation costs.

### BRIEF DESCRIPTION OF THE INVENTION

10 For a better understanding of the present invention the five preferred embodiments of the invention are to be describe hereinbelow and are represented in the attached drawing, wherein:

FIGURE 1 is a conventional diagram of a first embodiment of this invention, wherein the main components of the system are shown.

FIGURE 1B is a conventional diagram of a second embodiment of the present invention.

FIGURE 1C is a conventional diagram of a third embodiment of the present invention.

20 FIGURE 2 is a conventional diagram of a fourth embodiment of the present invention.

FIGURE 3 is a conventional diagram of a fifth embodiment of the present invention.

25 FIGURE 4 is a conventional diagram of a sixth embodiment of the present invention.

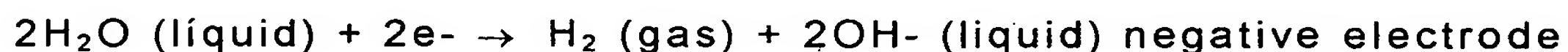
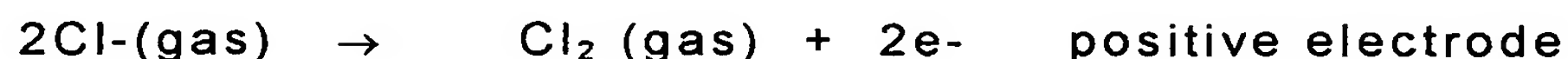
FIGURE 5 is a conventional diagram of a seventh embodiment of the present invention.

## PREFERRED EMBODIMENTS OF THE INVENTION

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### FIRST EMBODIMENT

Referring to FIGURE 1, the process starts as follows: A power supply 8 is temporarily used for starting the process. It can be a rectifier system to convert commercial alternating current (AC) electric power into direct current (DC), or any other type of known supply of DC. When this power supply 8 is activated, electrodes 1 and 1a are fed with DC, whereby starts the electrolysis of sea water which in its greater proportion consists of a sodium chloride solution. As an effect of the electrolysis, at the positive electrode small bubbles of chlorine gas 7 start to be formed, while at the negative electrode hydrogen gas bubbles 6 are formed, according to the following reactions:



These  $\text{H}_2$  bubbles tend to go upwardly through the tubes 3 and 2, respectively.

En this instance, said tube 2, with the hydrogen ( $\text{H}_2$ ) bubbles have the valve 9 shut up whereby said gas accumulates on the top of said tube, displacing thus the sea water originally filling

up said tube; the deeper the location of said electrodes 1 and 1A, the greater the pressure within said tubes.

Once the pressure is sufficient to operate the turbine 12, a valve 9 is opened and the hydrogen ( $H_2$ ) gas pressure moves said turbine 12 and, in turn, the rotation of a generator 4 produces DC power that is transmitted to said electrodes 1 and 1A. Once the operation started, the power supply 8 can be disconnected by the switch 18; and the entire system operates in a self-sustained manner as long as the distance 10 between the electrodes and the sea surface is sufficiently large.

In order to stop the system all that is necessary is to close said valve 9. This shall carry the turbine 12 to a halt. At the exit 5 of said turbine 12 a final product is obtained; said product is hydrogen ( $H_2$ ) gas with very high purity. As a byproduct from this process, chlorine gas is obtained at the exit 11 of said tube 3.

## SECOND EMBODIMENT

Referring now to FIGURE 1B, it is to be pointed out that the electrodes carrying out the electrolytic process can be multiple electrodes or pairs of electrodes which, once the operation started, can be partially disconnected by means of electrodes 18, 18a, as the amount of power being generated by the generator increases and less power is being required from the power supply 8.

### THIRD EMBODIMENT

Referring now to FIGURE 1C another manner of reducing the energy to be supplied from the power supply 8 to said electrodes when the generator 4 is increasing the amount of electric power generated, is the use of a timer 19, by means of which the on/off cycles can be varied and thus the power used in the process diminishes and, accordingly, the cost thereof is minimized.

### FOURTH EMBODIMENT

Making now reference to FIGURE 2 it is clear that the same principle can be used when the equipment is made as herein described, where a well is drilled and then is filled up with salt water, and the electrodes to carry out said electrolysis are located at the bottom of the well. Said well can be drilled within a salt lake or near said salt lake so as to take advantage of the salt water.

Said electrodes 1, 1a and tubing 2, 3 serve the same functions as described hereinabove, whereby the apparatus operates as previously described herein.

### FIFTH EMBODIMENT

Making now reference to FIGURE 3 it is disclosed another manner of constructing the equipment, similar to the one



previously described (cf. FIGURES 1 and 2); where a container 14 from any material is introduced within said drilled well 13, and said container 14 is filled up with water, that can be acidic or to which an acid, such as, for example, sulfuric acid ( $H_2SO_4$ ) is added, so as to make the water conductive. In this instance, as products from the decomposition of water there are obtained, further than hydrogen, oxygen gas whereby the pressure of this latter can be employed to motion another turbine 15 moving a second generator 16, so that a greater amount of power is generated and, at the same time, high purity oxygen 17 can be obtained.

#### SIXTH EMBODIMENT

In connection to FIGURE 4, another manner of use the principle of the invention is embodied in an underwater station 18, where the electrodes can be initially fed from a DC battery 8 to initiate the water decomposition, and wherein the tubing 2 transporting the hydrogen gas, carries said gas from the site of the electrodes down to a site near said station, where a turbine 12 is located. This turbine 12 is moved by the pressure differential, since the pressure at the interior of the underwater station is approximately same as the atmospheric pressure, thus generating electric power according to the same principle as above recited; and wherein the difference consists in that said hydrogen gas needs no to be carried out up to the sea surface. A valve 21 is operated

before the process starting in order to purge out the system.

### SEVENTH EMBODIMENT

5            Making reference now to FIGURE 5 another embodiment of the equipment is shown. In this embodiment, hydrogen coming from the tubing 2 under pressure, is directly supplied to a container 19 to the distribution and transport thereof.

10           Relating FIGURE 5.1, the equipment is similar to that corresponding to FIGURE 5; but in this instance a tubing 20 can be connected to transport said gas to the consumption site.

15           Once the invention described with the seven preferred embodiments thereof, it will be apparent to those skilled in the art that various changes and modifications can be made in this invention, without departing from the true spirit and scope of the invention as defined by the following claims.